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TECHNOLOGY UTILIZATION

MANAGEMENT TECHNIQUES

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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TECHNOLOGY UTILIZATION OFFICE 1970
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Foreword

The National Aeronautics and Space Administration and Atomic Energy Commission have established a Technology Utilization Program for the dissemination of information on technological developments which have potential utility outside the aerospace community. By encouraging multiple application of the results of their research and development, NASA and AEC earn for the public an increased return on the investment in aerospace research and development programs.

This publication is part of a series intended to provide such technical information. It presents a selection of management techniques in summary form, covering a wide range of efficiency and cost-saving programs. Representative techniques discussed in this volume include new management and training concepts; accounting and time-use methods which update costs for any given period; computer checks on engineering and schedule effectiveness; data reduction; automated forms and control; and long range planning of manpower.

Additional technical information on individual devices and techniques can be requested by circling the appropriate number on the Reader's Service Card included in this compilation.

Unless otherwise stated, NASA and AEC contemplate no patent action on the technology described.

We always appreciate comment by readers and welcome hearing about the relevance and utility of the information in this compilation.

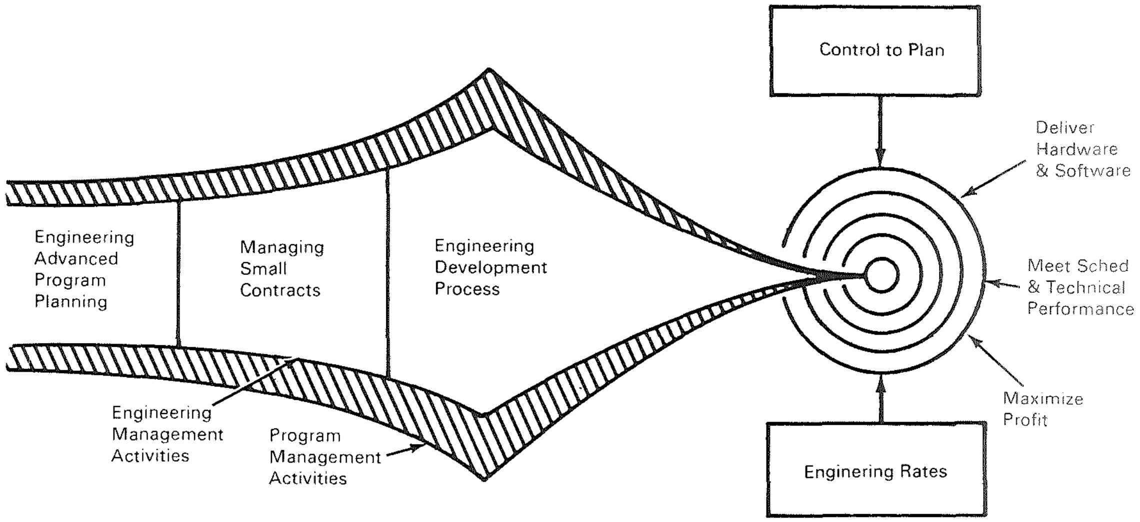
Ronald J. Philips, *Director*
Technology Utilization Office
National Aeronautics and Space Administration

Contents

Section 1. Management Training and Engineering

ENGINEERING MANAGEMENT FOR PROFIT

The sophisticated systems characterizing today's large industrial programs have shifted in emphasis toward engineering. As a result, manufacturing, materials procurement and subcontracting costs depend more strongly than ever on the quality of engineering output. In fact, both manufacturers and material suppliers must base their efforts primarily on the initial product of the engineering department, since changes made to rectify mistakes and improve the product are extremely costly. This fundamental approach may be adapted for use both in military and industrial applications.



Five major areas are involved: advanced program planning; managing small projects; engineering development processes which lead to integrated major program plans; control of the engineering; and program management activities and management of the engineering rates. These five performance requirements range from highly creative concepts to detailed control techniques. Their relationship is shown in the figure.

To discharge its total responsibilities in a manner which supports company profit objectives, engineering management must meet the following performance requirements: (1) Selection of the most promising programs and projects which form the building blocks for these programs, together with an integrated resources allocation plan, both for the systems feasibility and design studies and for supporting research technology; (2) Efficient management of the small building block projects to achieve project objectives within cost, schedule, and technical performance limitations; (3) Development of total major systems program engineering plans, including final systems test and customer delivery (Since engineering must integrate all functions in performing the system engineering task, the quality of its product has a critical impact on total program costs and profit potential.); (4) Development of efficient systems for the management and control of all engineering activities in major programs (including functional flow networks, management control points and methods, and procedures in the areas of system engineering configuration and data management, and design assurance); (5) Retention of competitive labor rates, both direct and overhead, while maintaining technical proficiency.

Other areas which enter into the equation of profitable engineering management are advanced program planning; managing small projects; engineering development process; controlling plans; engineering labor rates; and employee benefits.

Identification of these elements of engineering management which significantly affect profits throughout the spectrum of company activities has evolved into a technique based on practical experience in managing a large, diverse engineering organization, rather than as a result of particular study of engineering management practices or the application of any single management theory.

Source: J. F. McCarthy, Jr., and F. A. Aschenbrenner of North American Rockwell Corp. under contract to Manned Spacecraft Center (MSC-17020)

Circle 1 on Reader's Service Card.

GREMEX—A NEW MANAGEMENT TRAINING CONCEPT

GREMEX (Goddard Research Engineering Management Exercise) was developed to fill an important need in providing the necessary experience required for research and development (R & D) decision making. The approach is from a management point of view, rather than from a technological perspective. In today's space and defense oriented R & D, an acute problem exists—the effective management of vast manpower and dollar budgets allocated to projects with well defined goals, yet depending on a course of action evolved from many alternatives. This situation results from the vast and sudden deployment of science and technology. Where scientific needs and technological development must be considered in light of available manpower, funds and time schedules, GREMEX attempts to solve the problem by management simulation techniques.

A hypothetical project termed the Orbiting Optical Laboratory is the setting for this particular GREMEX exercise. A Project Development Plan (PDP) is given to the participant to study. Specific technical objectives already have been established, development and testing activities defined, and costs estimated. An optimum time to complete the project development also has been established. In addition, the probability of success of the testing program, i.e., project reliability, has been estimated.

Built into the model are "inherent success probabilities" involving reliability, and cost and time estimates of each of the development and test activities. As the exercise progresses, these estimates are used to determine the actual time and cost consumed and whether technical performance objectives were realized.

The participant to the exercise, acting as the project manager, influences performance, and cost and time estimates by decisions which he can make or defer if he chooses. For example, the participant determines the type of contract, selects the contractor, and quickly awards the contract. Use of proper judgement improves his chances of achieving time, cost, and performance objectives. Decisions are translated into computer instructions. The computer readout then gives the status of the project on the basis of decisions made, as well as other factors programmed into the exercise.

Plays and reports represent one month time increments, giving participants the opportunity to test old methods or try new approaches, without concern about potential rewards or penalties that might influence decisions made in real life.

Source: M. J. Vaccaro and M. F. Denault Goddard Space Flight Center (GSC-90574)

Circle 2 on Reader's Service Card.

ENGINEERING COMPUTER ACCESS CONTROL SYSTEM

The Engineering Computer Access Control System (ECACS) is a computer-operated visibility and control technique orginally developed for aerospace use. Its purpose is to help management identify, evaluate, schedule and give priority to such tasks as computer problems and engineering workload, from a systematic computer program output.

Early attempts to manage engineering computer support requirements were of a random nature. No data was available on a daily or weekly basis which would highlight the dynamics of engineering computer requirements. Priorities in computer work were simply the outcome of informal discussion between supervisory and management levels. Generally, the better priorities were awarded to the loudest voice, but no system existed to assure that management decisions were carried out.

The use of ECACS means scheduled and regular publication of data that provides management with comprehensive operations visibility. As a result, a program has been adopted for and is presently used on the IBM Model S/360/20 computer. Experience, however, shows that this engineering management tool can also be of interest and use to nonaerospace industries as a modern and efficient means of controlling operations. Its major value becomes apparent under conditions where it can be applied to processing inputs from numerous individual tasks originating in independent units, yet handled by common equipment through a single center.

Additional potential in this system lies in its adaptability to other types of management reports such as error summaries, reports of good as compared with bad hours consumed, and cumulative actual time relative to budgeted time. With minor modification, the data could be presented through a conventional plotter.

As the result of experience, basic improvements were initiated and five priority levels now exist. ECACS assigns the top four priorities to the engineering computer support requirements by deliverable item, in terms of computer jobs and time. Unscheduled engineer computer work automatically is assigned the lowest priority.

Two methods of operation have been developed. These are identical, except for the flow chart which could theoretically provide the ultimate in control. Due to budget limitations, the current system does not use flow charts. Scheduling is accomplished by the engineering groups through the use of data sheets.

Engineering also has two categories of chargeable items—those contractually deliverable and those nondeliverable. Computer work is scheduled and priority assigned for deliverable items only; therefore ECACS schedules, reports, and data input sheets carry deliverable item nomenclature.

An overview of the system reveals several features which are new in concept or application: (1) the entire (ECACS) system can be operated by one man; (2) the method of scheduling and assigning priorities to engineering support programs operates in terms of deliverable items and required time; (3) priority assignments are established on the basis of status against delivery; and (4) all digital computer work is accomplished on the IBM computer.

Source: F. P. Wright, R. G. Thompson and J. W. Brockway of The Boeing Co. under contract to Marshall Space Flight Center (MFS-15096)

Circle 3 on Reader's Service Card.

SYSTEM SAFETY ENGINEERING

System Safety engineering is a new concept governing the tabulation of objectives and definitions as applied to reliability, quality control, value engineering, and system safety.

As a result of considerable practical experience gained in the space effort, the complete integration of system safety into overall system effectiveness was achieved establishing crew safety require-

System Effectiveness Concept

Accepted Definition

Quantitative measure of extent to which a system may be expected to achieve a set of specific mission requirements.

"System Safety Engineering is a portion of the mainstream engineering effort, and as such, must receive consideration along with other engineering disciplines whenever trade-offs are made in interest of total system design". (USAF AFSCM 70-8 1966)

Figure 1

ments as part of the design assurance requirements and processes. Any large industrial program faced with product liability losses would benefit from the application of these ideas.

In the past, system safety engineering had a very limited application because it was considered a separate discipline from system effectiveness. Accordingly, little funding was provided for the implementation of system safety.

Carrying the present technique a step further, it is possible to establish relative tables of values between, for example, missile system product effectiveness and washing machine product effectiveness. While cost effectiveness is common to both, the system efectiveness of a missile system is translated into the product effectiveness of a washing machine.

Where software is related to industry, the system

Integration of Product Assurance Efforts
Tasks Common to all Disciplines

Analysis

Of product use and use to identify and determine value of characteristics of design and production to determine critical parts, functions, and events.

Controls and Constraints

Factors in design and production which determine characteristics or adverse effects.

Test/Verification

Verify effectiveness of analysis and controls, and measure values achieved.

Figure 2

effectiveness concept can also be applied. The accepted definition for this discipline is outlined in Figure 1 (System Effectiveness Concept), while the tasks common to all disciplines are given in Figure 2 (Integration of Product Assurance Efforts).

The integration principles and methods which follow, in turn lead to design assurance and the activities of an integrated program.

Source: D. B. Thomas of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16808)

Circle 4 on Reader's Service Card.

Section 2. Accounting and Cost Reducing

EXPERIMENTAL ACCOUNTING METHOD

By incorporating accounting information in the general notes on drawings used by the shop during fabrication, problems in accurate fabrication of experimental one-of-a-kind hardware have been solved. This is also true of assembly cost accumulation when used by production oriented organizations.

Experimental hardware drawings usually are limited to a specific part or assembly because of the nature of its end use. If a similar piece is subsequently required, new updated drawings incorporating current improvements are released for its manufacture. As a result, a particular drawing becomes associated with only one contractual change. In turn this allows charge numbers to be called out on the drawing face and substantially reduces dependence on any associated paperwork. Charge number information, for example, becomes directly available to personnel performing the work and encourages correct accounting for time and material.

This new approach results in reduced dependency on ancillary paperwork, and thus greater accurate cost accounting in one-of-a kind experimental hardware. Since drawings necessarily accompany work to provide the required fabrication instructions, the addition of applicable accounting information on the drawing assures its availability at the time the work is being done.

This system is applicable to many research projects where the evolution of hardware configuration is intrinsic to the program objectives.

Source: John R. Lauffer of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-18290)

No further documentation is available.

SLIDE CONVERTER—ACCOUNTING CALENDAR

The subject device, a slide converter, can instantly perform the job of equating (work) hours to equivalent personnel required for a given time span, without the need of paper and pencil. What is called an accounting calendar not only eliminates machine calculation, but is small and compact enough to fit in the pocket. This operation has been a continuing problem to industry, because if calculators are not available, both time and paperwork are required to project a valid estimate.

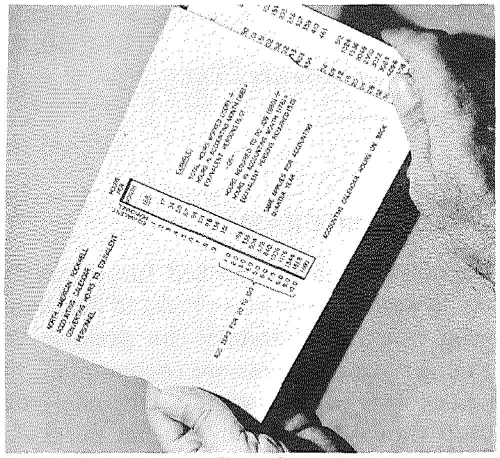


Figure 1

Under the new device, two sides, two windows, and a slide make up the slide converter-accounting calendar. One side of the card (the accounting calendar) shows the monthly breakdown in man-hours, based on the Government fiscal year of 2000 hours (Figure 1). On the reverse (or converter) side, the appropriate month is first selected by moving the slide. Suppose a particular month allows for 168 man-hours (Figure 2) while the project in hand requires a total of 1344 hours; the exact number of people required to do this job within the month can instantly be read off from the column at left of the window (in this case, 8 people).

The slide also allows for a quarterly breakdown column in any given fiscal year.

This device is extremely versatile. It can, for instance, be used by contract agents and financial personnel, or for almost any kind of proposal preparation. What is, in effect, a simplified kind of slide rule can also offer valuable service at meet-

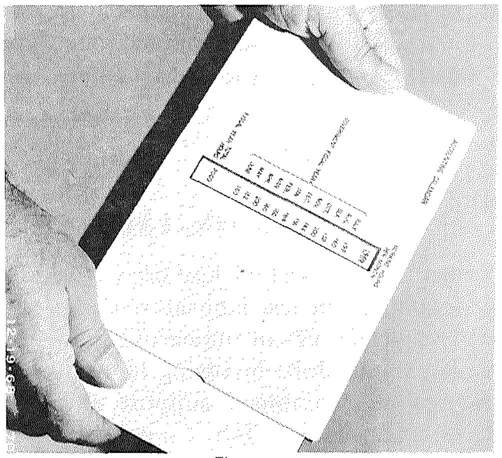


Figure 2

ings, during negotiations, or in connection with fact-finding sessions where electric computers or calculators are unavailable.

Source: Francis K. Christenson of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16529)

No further documentation is available.

COST-REDUCING MULTIPURPOSE MICROFILM CARD

A multipurpose microfilm aperture card has been devised that will substantially reduce the cost of purchasing, storing, processing and filing operations. Industrially, this innovation should prove valuable for limiting the number of microfilm formats now stored by many firms. Since microfilm aperture cards already are in general use throughout industry, the present disclosure should prove applicable to virtually all companies using cards. It should also be of benefit in automated or programmable information storage and retrieval systems. Designers and manufacturers of data processing and storage equipment and manufacturers of data processing forms also will find the idea interesting.

The advantage of the multipurpose microfilm aperture card is that it does not have the format printed on one side only. The format on one side necessitates the stockage of cards for mounting each generation of film used and in each format required; the new card eliminates these problems. Users will now be able to limit their purchase and inventory to two types of cards in each format needed in their operations: namely, aperture cards into which film can be mounted, and duplicards (aperture cards with duplicating film mounted in them at the factory but unexposed) onto which other images may be copied.

Additional problems which can be eliminated include: (1) determining format, form number and the appropriate film image plane on at least four numbered forms for each basic format; (2) maintaining large stocks of cards for first through fourth generation films, both aperture and duplicate cards; and (3) countering difficulties in filing and processing cards that have inset film of intermixed face and back image plates.

The new multipurpose microfilm card is essentially a standard 80-column punch card, printed in the same format on both sides. The card is prepunched with information indicating the direction of the image plane of the inset microfilm slides. Printing the same format on both sides of the card enables the user to limit himself to one card for mounting films that are "right reading" both on the emulsion side and the base side.

Source: A. V. Smith of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10508)

Circle 5 on Reader's Service Card.

LABCON—LABORATORY JOB CONTROL PROGRAM

A budget control system has been developed for use in component test laboratories where the workload is made up of numerous individual budget allocations. Jobs involving laboratory efforts require the combined support of several groups; the Laboratory Job Control Program (LABCON) coordinates this effort into an effective cost reduction tool which fills an important industrial need. Basically, LABCON utilizes a common denominator which is applied to an incoming job and to which all effort is charged and accounted for. The common denominator is the Laboratory Job Number System and the facilities of the data processing department.

When a request is made for the performance of a specific job, all conditions and limitations must be included. The request passes through the laboratory planner to be checked for authorization, then to a supervisor who checks to determine whether or not the laboratory can perform the task. If no serious problems are encountered, the unit planner inserts the work into the computer with a Job Input Data Sheet for that particular job. The type of job determines which is the prime unit or group for the test. The Prime Locator Card is then issued to that unit. At this time it is already known which of the other units will be required for the job. The planner then issues to each involved unit a Support Locator Card and a copy of the request document.

Each week, employees make out weekly job cards. The form has a keypunch format and contains spaces for the employee's serial number, the job number, straight time and overtime hours, and the laboratory unit code. After the cards are keypunched, the computer tallies all hours worked against this given job file number, each week, and carries these hours over from week to week. In this way, when the job is completed all laboratory effort generated by the request is compiled.

The unit code number serves as a function and/or equipment utilization code. Through selected sort and list operations, this code provides valuable information required for proposals and equipment justifications based upon the amount of loading on a particular facility system or function. When the job is completed, the prime unit planner is responsible for closing out the job, first making certain that all functions of all laboratory units are complete. This is the primary purpose of the support card, for when each supporting unit completes its portion of work, the Support Locator Card is returned to the prime unit's planner, together with the copy of the document. The job may be closed only after all support cards have been returned and the prime unit is complete. At this point the prime unit planner fills in a Job Update Data Sheet. This codes the machine to carry out the normal program functions the week the program is submitted, and then to drop the job from all further carry-overs.

In addition, the program generates a History Card for the completed job, indicating the hours required to accomplish it and giving a general description of the work done. This card is then filed both by job and document number for easy reference.

Source: L.T. Reams of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-18141)

Circle 6 on Reader's Service Card.

UTILIZATION SYSTEM FOR MACHINE TOOLS AND PROCESS MACHINERY

A data acquisition method has been developed which is applicable to industries concerned with metal working, plastics, and plywood. This method provides the exact time of machine function for the purpose of scheduling, cost accounting, equipment amortization, cutting tool life, and management visibility.

The primary element of equipment for collection and dissemination of data is a Recording Console, a Central Data Collection Station which records the actual utilization of up to 1000 remotely located equipment items. Each piece of equipment is connected to the recording console by 24-volt bell wire. Utilization of this equipment is recorded on eight-channel tape in terms of real running time and/or time under load.

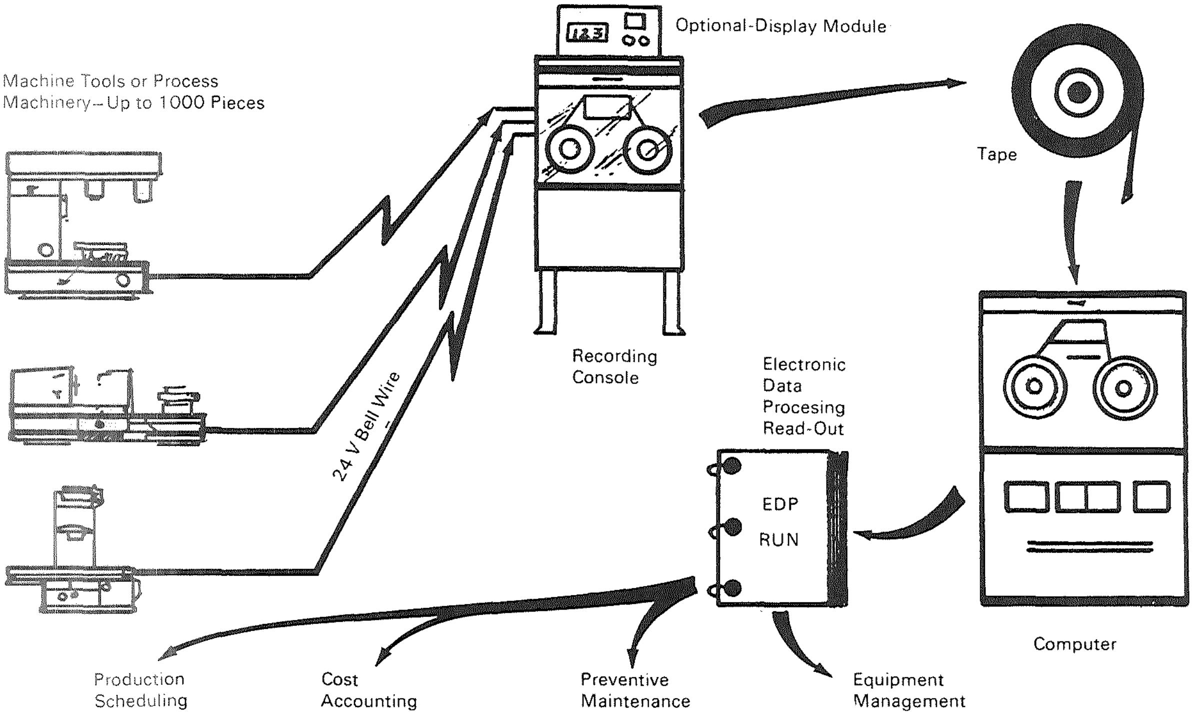
The tape output from the Recording Console (see figure) is fed into the computer, which may be programmed to extract and tabulate the data in any desired manner. The output will be in a form similar to that of the existing electronic data processing (EDP) run. Such information as daily, weekly, and monthly running and load time are included. In addition, these figures can be compared with standards showing plus or minus deviations. This permits the updating of standards from day to day and week to week.

The general purpose of this innovation is to provide accurate, current machine tool and general processing machinery utilization data for (1) production scheduling; (2) preventive maintenance scheduling; (3) management intelligence; and (4) cost accounting.

The computer readout is in the form of a tabulation that describes the actual running time and hours of work performed by any machine on the data acquisition circuit on a daily collection basis.

Tabulation can be arranged to provide management and/or planning group visibility on any function deemed necessary.

An example of the versatility of auxiliary transmitters is their ability to monitor such functions as coolant flow and pressure, continuous forced lubrication systems, toxic and noxious vapor or gas ventilation systems, and maintenance alarm systems. The auxiliary transmitter also can perform such tasks as providing data for cost accounting; identifying excess capacity, heavy loads



or excessive maintenance downtime by equipment number; removing the element of human error; and eliminating the possibility of bias figures. Transmitter output data identifies equipment by inventory number and status.

In the overall picture, the automatic system of recording actual machine tool and/or processing equipment utilization data will provide equipment management with an accurate, up-to-date basis for assignment of equipment; guidelines for planning realistic schedules; advance visibility on potential schedule slides; management intelligence with a realistic means of gaging excess capacity and/or machine tool or processing machinery deficiencies, thus giving management a more knowledgeable position in new competitive bidding situations; and continuous monitoring of critical machine and safety parameters.

The advantages over conventional monitoring methods including inconspicuous hookup to recording console or display module; little or no modification cost or capital investment for the acquisition of equipment to be monitored; no need of manual tabulation; and lower installation and operation cost.

Functional capabilities of the equipment are highlighted by its ability to operate 24 hours a day, 365 days a year, in a general factory environment. This assumes a temperature between 40° and 120°F, and a relative humidity of 80 percent. The operation of the system remains unaffected by any normal factory airborn contaminates.

Source: Jacques P. de la Vergne of
The Boeing Co.
under contract to
Marshall Space Flight Center
(MFS-14289)

Circle 7 on Reader's Service Card.

PROCEDURE FOR FORMATTED CALCULATED DATA

A Formatted Calculated Data Template which aligns computer tape output to identified cost elements on the template overlay represents a large improvement over existing methods used to price, check, and document projected cost reports (PCR). These methods, which are unnecessarily complicated and therefore time consuming, reflect an attendant rise in costs. Routinely, a desk top computer is utilized to price a man-hour estimate. The computer's type output is then transcribed to a PCR boilerplate and the information is typed. A mathematical check follows to assure accuracy before reproduction of the finished PCR.

The same job can be done more quickly, with greater accuracy and at much less cost by the Formatted Calculated Data Template; the assembled data is then sent to reproduction for formal copy without any typing being required.

The primary advantage of utilizing this procedure is the substantial savings in response time to documentation deadlines. Previous documentation required that computer data output be identified with the financial element it represented, then translated to a boilerplate before submitting to a typist.

After typing, the data had to undergo a mathematical check to assure typing accuracy. Only then was the typed financial report sent to reproduction.

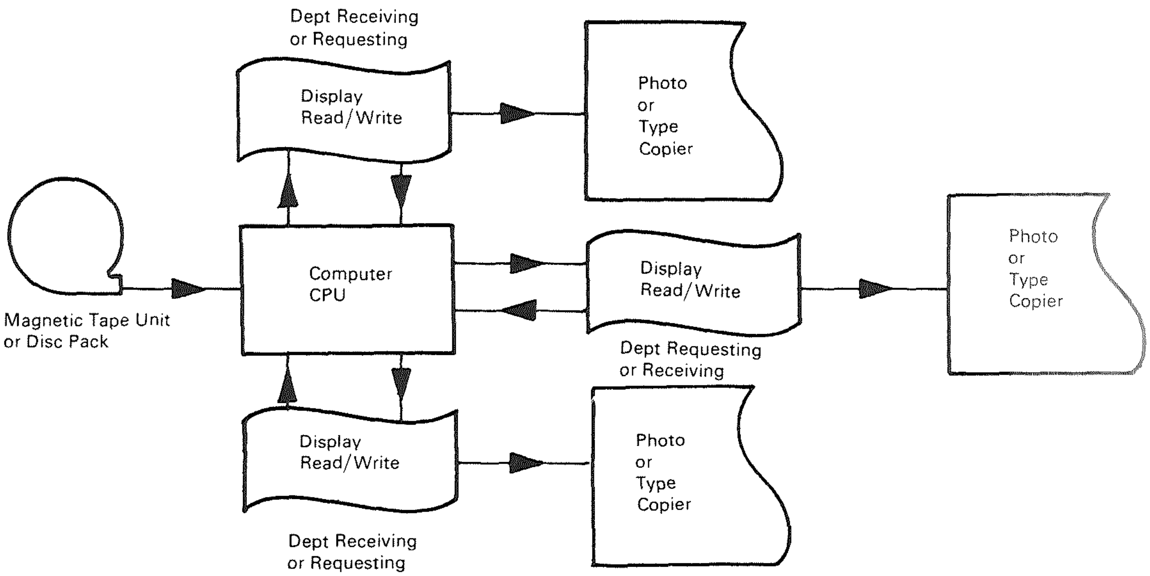
Under the disclosed procedure and by utilizing a preformatted template, the documentation process now consists of taking computer tape output, inserting tape into the template, and going straight into reproduction without further typing. This new process allows the entire documentation to be accomplished by one individual, compared to at least four persons required by the old method.

The new technique has a wide scope of industrial application and can be used for the formatted calculated data documentation required for engineering data output, budgets, or other financial data in any data oriented organization.

Source: E. D. Bass of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10500)

Circle 8 on Reader's Service Card.

AUTOMATED FORMS AND FORM CONTROL



The disclosed procedure is an automated system of form control which utilizes the time sharing potential of the computer system with display/write devices that are capable both of input and output (I/O). A program is written to store all applicable types of forms (see figure) on magnetic tape or disc pack. The program then processes the form to the applicable department which calls for it (by form number). Any organization utilizing a vast quantity of forms should benefit from this method which offers multiple advantages such as 1) reduction of processing time by as much as 75%; 2) elimination of the need for most forms and their storage and inventory; 3) ability to assess departmental cost; 4) reduction in personnel handling and transportation; 5) programming out of obsolete forms; 6) cost reduction by as much as 50%; 7) centralized and computerized form control; and 8) form standardization by as much as 20% due to commonality.

The time consuming and tedious problem of producing, storing, and cataloguing countless forms has largely been solved. Another important feature of this type of automation as it relates to forms is the ability to take advantage of time sharing and display devices such as the IBM electric typewriter display unit.

Source: W. W. Lasken and P. Y. Hamasaki of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-16427)

No further documentation is available.

Section 3. Planning and Reliability

LIMITED FACILITY ALLOCATION NOMOGRAPH

The existence of possible conflicts in the use of facilities, where one or more critical tests are run simultaneously, has been a serious problem. Several techniques have been developed to cope with this situation, but none has possessed the advantages offered by the Limited Facility Allocation Nomograph, which consists of a multicircular slide rule arrangement used to align requirements and show visually whether any conflicts exist.

One of the most important attributes of the Limited Facility Allocation Nomograph is its applicability to industry in a multiplicity of areas. Included are airline emergency traffic control; flight line scheduling of facilities utilization; automotive assembly line emergency changes; railroad yard contingency scheduling and dispatching; large city road traffic control during peak periods; and production control.

The sliding scale type of calculator used consists of three components and a spring-loaded means of attachment. Two of the components or discs are movable. The third, which is stationary, acts as a base plate. The outer disc is divided into an equal number of sections, each of them identified by a code number which can be used to designate a given piece of equipment or an operation function. The number of operations or functions involved determines the number of sectors required.

Each sector is in turn divided into an equal number of subsections, identified in all cases by a code letter designating a facility, major system, piece of equipment, or a numerical estimate of manpower. A rectangular window is located at every subsector on the outermost row; these windows also are found where required on inner rows. Color coded identification in these windows is supplied by the base plate.

The inner (or middle) movable disc also is divided into equal sectors, but in this case the dividing lines (not the sectors) are each identified by a code number designating a test scheduled to take place at the same time as any of the tests designated on the outer disc. Inner disc windows are located at each sector line. These are single windows long enough to accommodate the required number of rows involved. A single pointer aligned with any one of the dividing lines of the inner disc is permanently attached to (or part of) the perimeter. It thus acts as a facility locator in conjunction with the base plate facility selector.

The base plate is divided into the same equal number of sectors as the inner disc. Each of these discs is further equally divided into the same number of subsectors contained within each sector of the outer disc. The lines encompassing any of these sectors and the subsector lines contained within them are extended radially beyond the circular perimeter of the inner component. They are identified with the facility code letters to form an offset facility selector.

The actual color codes, in the form of rectangular blocks, are permanently affixed to the base plate and are revealed via rectangular windows through the two movable discs. At least two rows are required for any one application, depending on the number of variable and/or inconsistent factors involved. The innermost color displayed (green, red or yellow) determines the type of constraint explained on the back of the base plate.

The first two rows indicate virtually all of the facility constraints resulting from various test combinations. The third row is incorporated to correct the few errors resulting from the random nature of the facilities or test combinations involved. The fourth row corrects the errors resulting from the addition of the third row. Placement of color rectangles can be determined experimentally.

To accommodate combinations involving the performance of three or more operations, a movable disc (laid out in a similar manner and having the same function as the outer disc) can be included for each additional simultaneous operation. However, any extra disc must have a smaller diameter than the one preceding it and still encompass the outer circumferential row of windows. Care must be exercised during the initial design to allow for possible future additions.

Source: Jules Wetekamm and B. P. Broughan of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10512)

Circle 9 on Reader's Service Card.

PROBABILISTIC APPROACH TO LONG RANGE PLANNING OF MANPOWER

Probabilistic Approach represents a detailed study of a long range planning model for project-oriented organizations.

The problem generally encountered in long range planning is the development of a total system which encompasses all areas of the corporate structure. Included is the correct identification of the factors bearing on the various sections of the planning agency and upon which estimates are made. The object of this approach is to keep pace with the headlong technological advances since World War II in areas of vast industrial potential such as electronics and flight oriented engineering.

A planning system which originates at the project level and consolidates into an overall plan, is modularized as follows: 1) development of appropriate techniques forecasting the number of personnel required on each individual project; 2) development of the distribution functions for the forecasted personnel requirements over the time span of the projects; 3) presentation of a method of consolidating the individual probabilistic forecasted manpower requirements into a total manpower plan; presentation of a method for determining the associated totals of personnel and material costs, and the acquisition, termination and requirement schedules.

A planning system originating from a budgetary ceiling or objective and allocated to individual projects includes these factors: 1) development of the appropriate model or models to forecast and allocate a total dollar value to the budget and determine budgetary limitations for each project; 2) translation of the project budgetary limitations into manpower and support requirements; 3) development of the distribution functions for the allocation of manpower over the time span of each project.

The above two planning systems are then analyzed to furnish management with the necessary data for decisions relating to project realignment and selection.

Source: R. J. Lejk of
Texas A&M University
under contract to
Manned Spacecraft Center
(MSC-11524)

Circle 10 on Reader's Service Card.

PRESSURE TRANSDUCER CALIBRATION DATA IBM REDUCTION FORM

Two new input forms have been designed to handle pressure transducer calibration for IBM data reduction. The new NA-27440 pressure transducers require more than twice the usual number of calibration points, which under the old system tended to produce poor readability of data over some 16 pages, together with a greater possibility of error, difficult to locate.

The two new forms are used in place of the 16 previous ones and they are most efficient and virtually foolproof in application. Added advantages include improved readability, reduced paper and IBM card usage, handling ease, and fewer computer requirements.

These forms should therefore prove highly useful to manufacturing as well as R & D personnel. Furthermore, new items require a shorter time to complete and can be read more easily.

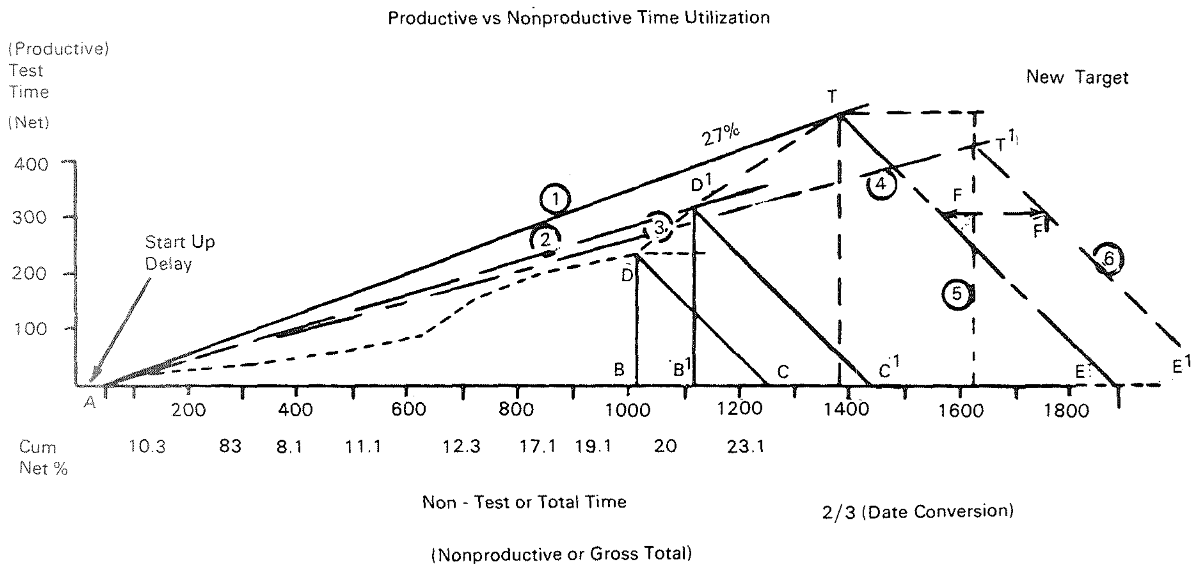
Essentially, an IBM data reduction card is punched a minimum number of times, which means less work for the computer and a greatly reduced risk of error.

Source: J. A. Klea
Marshall Space Flight Center
(MFS-12380)

Circle 11 on Reader's Service Card.

NET/GROSS RATIO COMPUTER

Using a grid and ratio calculator as a working plot, or an overlay on a similar chart, the Net /Gross Ratio Computer has the capability of keeping track of progress in relation to the total estimated production time for completion of a specific job. Formerly, one or more readjustments was always necessary to update a project and arrive at the percentage completed compared to new target schedules. Attempts to solve the problem of keeping to schedules were based on a series of incremental plots, calculated arithmetically. "Percentage to Go" ratio was calculated for cumulative plots. With this new approach, it is possible to determine the ratio of point or cumulative times or costs to planned target requirements. A comparison of essential overhead productive hours versus nonproductive time utilization is also possible with this new system (see figure).



This method is adaptable to many phases of commerce and industry such as net-to- gross cost ratios, productive/nonproductive effort, get-well rates to new targets, time or products to go, net-to-go to target, and rapid selection of targets. The promotion of rapid processing, low cost building, accuracy and precision, and the elimination of the need for a skilled operator represent important capabilities.

Source: LaVergne C. Jochim of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15070)

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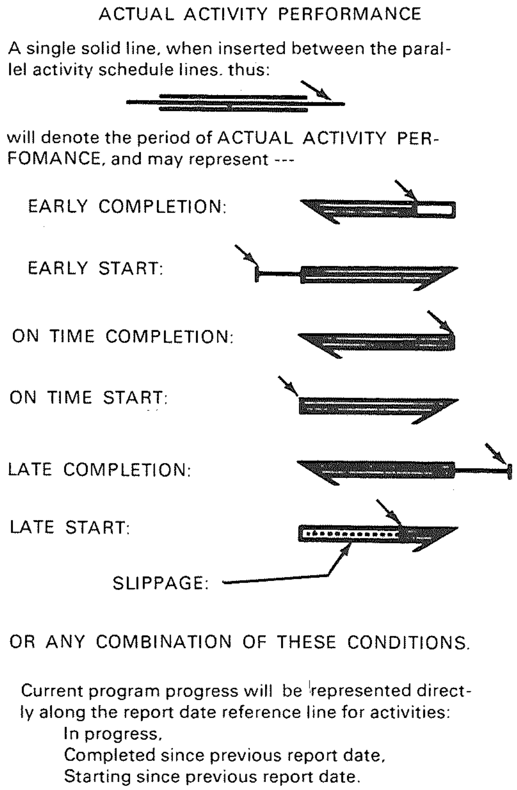
VIS-A-PLAN (VISUALIZE A PLAN) MANAGEMENT TECHNIQUE PROVIDES PERFORMANCE-TIME SCALE

Vis-A-Plan is a bar charting technique for representing and evaluating project activities on a performance-time basis. This technique offers a number of distinct advantages, both to manage-



ment and work force, since it is relatively simple to use and interpret. It should therefore find many applications in management practice covering a wide range of activities, including aircraft maintenance, manufacturing, publications production, government agency operations, and research project and procurement activities. Another outstanding use appears to be the making of surveys and the preparation of project reports in almost any work area.

Essentially, Vis-A-Plan condenses information from many documents and planning elements into a single time-scaled picture from which one can determine activity sequence and interrelationship, key events and dates, concurrent activities, procurement lead times, critical situations, and project status.

Vis-A-Plan is best described as a rectilinear method of charting that presents logic diagrams of projects in a series of horizontal time bars consisting of Network Notations and Program Progress Reporting (see figure).

Although compatible with and supplementary to Program Evaluation and Review Technique (PERT), this method may be used independently in planning development without the need of sophisticated machine programming and computer analysis. In terms of event/activity, there is a basic relationship between Vis-A-Plan and PERT, but the manner of display differs significantly. In PERT, activity is represented by a line with an arrow showing the direction of activity flow. The length of the line has no real meaning in terms of graphic presentation of time span. In Vis-A-Plan, the length of the activity bar represents the true length of the planned activity indicated by a time scale. Each activity is identified by notations describing it and the individuals or offices responsible for its accomplishment. Vis-A-Plan also uses alphabetical coding along the vertical axis, thus facilitating location of any stage of activities by rectilinear coordinates.

Two types of activities generally are shown with the Vis-A-Plan chart: series and parallel. Series activities which have direct relationships and modifying effects upon each other are depicted as a series of steps. Parallel activities are those which proceed independently and concurrently, appearing as parallel bands. To simplify and standardize charting, network notations and reporting methods also are shown.

Source: N. H. Ranck of
TransWorld Airlines
under contract to
Kennedy Space Center
(KSC-10073)

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RELIABILITY CONCEPT FOR TESTING DEVICES

A concept for testing devices has been formulated in which a small number of items, subjected to repeated simulations of mission conditions, can be used to verify compliance with design and performance requirements. Simultaneously, the achievement of a specified reliability can be determined.

Use Reliability is defined as the probability that a device will perform without failure of a specific function after exposure to a given set of conditions for a predetermined period of time. This is the true basis for a reliability concept in testing aerospace ordnance, but the scope of this concept is much broader and is applicable to most types of industrial ordnance. The Use Reliability Index can be used to determine the probability that a device will perform without failure a specific function after exposure to a given set of conditions for a given period of time.

Activation of this reliability concept was due to the fact that the performance of high-explosive ordnance equipment is a reflection of the degradation accumulated during an inactive period, rather than during the swift detonation phase. A more efficient index would therefore be a measure of survival over the inoperative interval.

The tests used to measure Use Reliability in space are called mission life tests which demonstrate that the degradation of ordnance over a period of time will not be enough to reduce the Use Reliability Index below the desired level.

Before the device can be subjected to mission life tests, it must be aged by exposure to those environmental stresses which it would normally encounter prior to its final mission. These tests, which are called premission tests, also are used to establish (with confidence) the initial failure rate level at the beginning of the mission tests.

Where items are not qualified under laboratory simulation programs, field usage data relating to them are collected. Included are time and/or cycle data, failure data, and conditions under which the items operated. These data are then transformed into mission-cycle factors so that mission reliability can be assessed. This type of operation is classified as field usage assessment analysis. Parallel tests, however, can be structured for a wide variety of ordnance applicable to industry.

Source: Arthur S. Eckstein and
Cornelius Groves of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16083)

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COMPUTERIZED SCHEDULE EFFECTIVENESS TECHNIQUE

A means is now available for determining future industrial or business performance through a computerized scheduling system which projects current schedule performance as an indicator. Management is thus provided not only with an indicator of organization effectiveness, but also with a reliable projection of future performance. This permits an evaluation of trade-offs involved in scheduling changes which might result from the incorporation of additional tasks. It should prove valuable in saving time and reducing costs for most forms of complex industrial management.

Schedule Effectiveness Technique (SET) is far superior to existing techniques which use a simple comparison of the rate of activity completion, where short activities count as heavily as long ones.

SET derives its original index as follows: each of the multiple activities of a schedule plan has a specific time span. The common unit of time measurement for an activity is termed a "flow week." For example, an activity with an estimated duration of 10 weeks is weighted twice as heavily as one of five weeks. Each activity has a demand date which must be met to achieve schedule. The median scheduled completion date of incomplete activities is established on a daily basis. The actual date is then compared with the average completion data, based on the rate of flow-week completions. Thus, an overall program schedule position can be established and reduced to a schedule-effectiveness index. The inputs are derived from a PERT or equivalent automated input system. The resultant index is a composite indication resulting from all schedule position variables.

The trend of observed schedule positions follows an exponential improvement curve, once the initial program activity is established. In this case, the program is written in FORTRAN IV for use on an IBM 7094 computer or an IBM 7040-7094 direct couple system with a 32,000 word memory and dual tape channels.

Source: D. Ballard, J. Birdsong, and R. Calva of
The Boeing Co.
under contract to
Marshall Space Flight Center
(MFS-13012)

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Section 4. Automation

DIAL-A-WELD ROD VENDED CONTROL DEVICE

A method has been proposed which will enable weld rod materials and diameters to be mechanically controlled through the use of a "weld rod usage" card. Based on information provided by the card, the mechanical device selects the correct welding rod and checks both diameter and material. The card is retained as a record, showing how much rod was used on each welded part.

This method represents a valuable improvement compared to the accepted system in which the selection of welding rod for any particular job is a random manual job depending solely on operator accuracy. Under these circumstances, any error in rod selection obviously would have a direct effect on operator performance and the quality of a welded joint.

The control device operates as follows: a drum, or roto-holder is mounted on a supporting structure. Various weld rod types are stored in a roto-wheel fitted with radial compartments about the shaft of the drum. Each compartment is equipped with a spring-loaded retainer, while the device operates on a signal generated by a "weld usage" card. The card is inserted in a receiver on the face of the drum, which causes the roto-mechanism to release the appropriate weld rod into a test holder. Here, the diameter and material are verified by an eddy current technique. Upon acceptance based on test versus card information, the card is punched and retained as a record while the rod is made available to the user.

A manual dial can be fitted to this device which will normally be locked out. Manual operation is intended only as a backup in the event that problems prevent automatic operation.

Source: B. Roth of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14211)

No further documentation is available.

AUTOMATIC COMPUTATION OF DATA-SET DEFINITIONS

A mathematical method has been evolved for construction of a computer program data-set description. This is obtained from a computer program containing detailed declarative information.

The improvement of the present method therefore stems from its modified approach to the problem which uses conventional set-theoretical union rather than disjoint union. Most conventional programming systems that attempt to provide flexible and efficient data representations require the user to specify the range of variables, parameters, and functions by extensive and detailed data-structure declarations. Much of this information appears, however, to be redundant and can be inferred from the nondeclarative portion of the program.

To secure the desired result, it was necessary to finalize the concept of a data-set description or definition. The most elegant earlier formalization considered a data-set definition to be a group of recursive set equations using the operations of a cartesian product or disjoint union.

With the new method, a data-set function is considered to be a special case of a recursive set definition which is, in effect, a group of equations. Cartesian products and disjoint-union operators are used to yield a series of recursive group equations. From the definition of a List Processor (LISP) function and a recursive definition of a set of all arguments for the function, a recursive definition was constructed that includes all results of the function. The construction method recovers a portion of this information from the function definition itself.

The reference cited, (Automatic Computation of Data Set Definitions; J. C. Reynolds, Argonne National Laboratory) provides a more rigorous treatment of the material, including proofs of several implicit and explicit assumptions made in the body of the paper. Two sections deal with recursive set definitions in general and with their specific applications to the description of LISP data sets.

Source: J. C. Reynolds
Argonne National Laboratory
(ARG-10475)

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VERIFICATION PROGRAM GUIDELINES

The present verification program logic network is new in that it standardizes the overall verification process of industrial evaluations. In the past, aerospace engineers on the Apollo program relied on judgment to determine the scope of testing required to verify new, modified, or existing equipment. This approach necessarily varied from extremes of qualitative guess to extensive analysis in an effort to determine test requirements. At best the old method produced inconsistent results until specific guidelines were evolved to organize an overall system for defining and implementing a test program in support of hardware verification and cost constraints.

The steps employed in the disclosed verification program are: (1) defining design and performance requirements; (2) evaluating equipment capability by similarity, design correlation, and criticality; (3) verifying equipment by mathematical extrapolation or computer analysis; (4) verifying equipment by testing. (Standard formats to perform evaluations are new and simplify the approach used by engineering disciplines.)

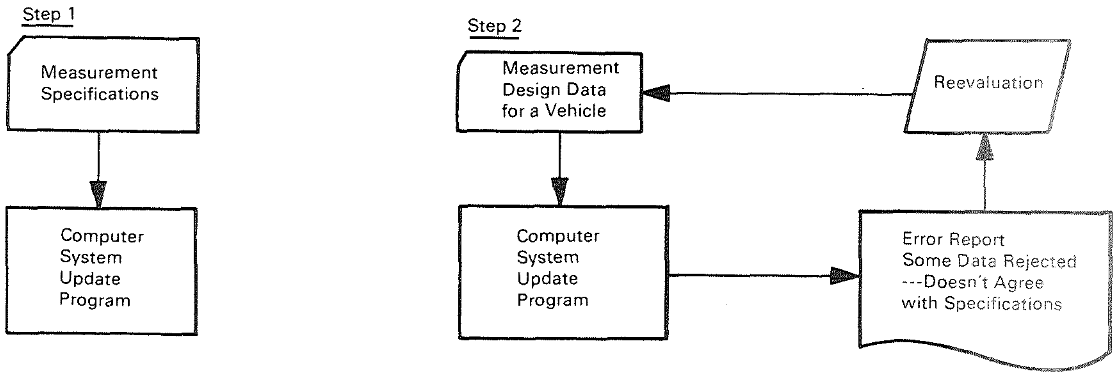
The above technology can be applied to any hardware producing program where a pretest analysis is necessary to determine hardware capability for discrete uses and test requirements.

Extensive and detailed documentation is necessary to carry the verification program logic network through its multiple phases, but the plan is flexible for adaptation to hardware of all types.

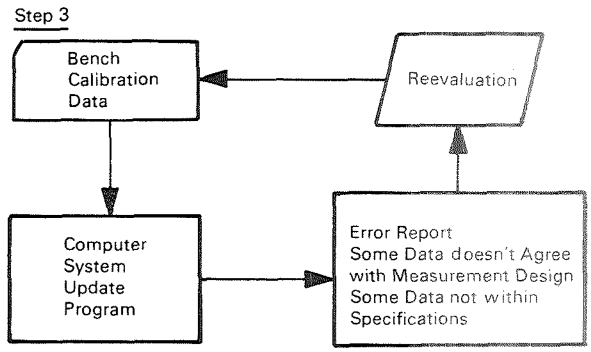
Source: Irving Bailis and Norman Samuels of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15523)

No further documentation is available.

INTEGRATED COMPUTER SYSTEM



The present Integrated Computer System has drastically improved a situation which for a long time hindered computer-directed management techniques. These techniques showed a marked weakness in one specific region—monitoring data input by providing automatic communication between three discrete areas of responsibility: specifications, design, and manufacturing. As a result, it was not possible to catch data discrepancies due to human error or omission.



Another important aspect of the automatic communication system is that it can be employed in any industrial operation where data generated by one department has an impact on the operations of another department.

In coordinating, for example, space vehicle measurement data files, the system receives data according to the sequence of work on the vehicle. First, specifications (data requirement) must be established. Next, measurement data must be processed. Finally, when the vehicle is assembled, measurement calibration data go into the computer for evaluation. The system provides an initial interface among the three areas which supply input data (steps 1 and 2 in figure). For any one measurement on a vehicle, design data that disagree with specifications are rejected, as are calibration data that disagree with either design or specifications. Whenever data are so rejected, an error report provides enough information to expedite evaluation of the discrepancy and resubmission of good data.

The interface function of the system continues on a dynamic basis, coordinating changes from one area with the other areas affected. For example, if a change is made to a particular set of specifications, every item of design and calibration data covered by those specifications is reviewed and reevaluated. The program makes the decision whether or not the data conform to the revised specifications (step 3). If they do not, the program apprises the person(s) responsible for that data in the specifications change and the resultant discrepancy.

Until such discrepancy is resolved, the responsible person receives with each successive update run a reminder that the discrepancy exists. Meantime, all data related to the discrepancy are rejected by the program. Procedures followed for changes in design and calibration data are analogous.

The novel features of this technology lie in providing a man/machine interface in three distinct geographical and time-separated functions through one integrated computer system which can readily be adapted to industrial needs.

Source: L. C. Carrington and W. C. Beamer of Chrysler Corp.
under contract to
Marshall Space Flight Center
(MFS-14639)

No further documentation is available.

NASA-Langley, 1971

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